Blood Flow Restriction Training

KINE-3415-002

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**Chapter 1: Introduction**

1. **Physiological Area:**

Neuromuscular Training Effects

1. **Rationale:**

Blood flow resistance training is a training technique created by Japanese inventor Yoshiaki Sato back in 1966 while attending a Buddhist festival. Also known by many names such as occlusion training, vascular reduction (VR), and KAATSU training, blood flow resistance training or BFRT has been an up and coming form of training over the past 50 years (Yasuda, et al., 2011). Apparently while kneeling, he experienced a reduction of blood flow to his calves which caused him to have a painful increase in pressure to his lower limb muscles. While attempting to massage his leg to get the blood flowing back to his muscles he noticed a slight “pump” in his calf similar to that of which one might experience after doing calf raises. Since then, blood flow resistance training has become a tool not only used in body building but also in rehab and medical interventions around the world (Yasuda, et al., 2011).

In order to use blood flow resistance training it is important to know what is happening during exercise with BFR and what makes it deemed a reliable form of training. Before exercising, place the band above the muscle that is going to be doing the work (lifting the weight). The band ideally should be fairly tight but not completely cutting off circulation to the limb. As the exercise commences, veins are being restricted during concentric contractions so that blood is still able to enter the muscle by the deeper laying arteries but unable to leave via the superficial veins. When this occurs there is a buildup of pressure in the capillaries prohibiting hydrostatic fluid from crossing membranes into the surrounding tissues, more importantly muscle tissues. Blood is then backed up in the arteries while pooling up in the veins decreasing blood flow to the muscles while metabolites build up. With each contraction the muscle swells with increasing volume of each muscle fiber (Lixandrão, et al., 2015). The fibers will continue to grow with each contraction of the weight due to hydrostatic pressure by the artery until you either remove the BFR band (venous block). This will force them to either adapt and grow or burst. Since the overall reasoning for resistance training is to tear and breakdown muscles cells causing them to repair and grow back this method of training may be very useful for some users.

Furthermore, the key idea aside from venous restriction is the ability to gain muscle hypertrophy and strength while using a fraction of a person’s 1 repetition max (1-RM). Since 20% of 1-RM seems to be an ideal ratio to begin with, it allows a person to perform more repetitions, preferably until failure, and get the same, if not more benefits than lifting say 70-80% 1-RM. This concept of drastically reducing the weight also reduces the overall stress placed upon muscle and joints which allows this to be a suitable form of technique used in physical therapy or hospital settings since a lot of the patients are recovering and cannot lift heavy weights. Lastly, some of the other benefits of occlusion training include;

* An increase in nitric oxide production of the body.
* An increase in motor unit activation and muscle fiber recruitment,
* An increase in lactic acid production which leads to lactate threshold improvement and an increased secretion of GH, Myostatin GD8, HSP and Nitric Oxide Synthesis. (Vechin, et al., 2015)

1. **Hypothesis:** It is hypothesized that BFRT can result in greater muscle strength and muscular hypertrophy than traditional resistance training alone.
2. **Purpose:** The purpose of this research is to examine the benefits of blood flow resistance training to tradition forms of resistance training and how it compares/contrast the effects of muscular hypertrophy.
3. **Key** **Terms**:

Muscle hypertrophy- Enlargement of an organ or tissue from the increase in size of its cells.

Venous Occlusion- Extremity venous occlusion describes a condition in which the vein coming from the arm or leg into the chest becomes narrowed, blocked, pressed, or pinched.

1 Repetition Max (1-RM)- The maximum amount of weight that a person can possibly lift for one repetition.

Muscle strength- The maximum amount of force that a muscle can exert against some form of resistance in a single effort.

EMG- Electromyography is a diagnostic procedure that evaluates the health condition of muscles and the nerve cells that control them.

MRI-Magnetic Resonance Imaging is test that uses powerful magnets, radio waves, and a computer to make detailed pictures inside your body.

Blood Flow Resistance- exercise approach whereby resistance exercise or aerobic exercise is performed whilst an occlusion cuff is applied to proximal aspect of the muscle.

Lactate Threshold- Lactate threshold is the maximal intensity that an athlete can maintain for an extended period with little or no increase in lactate level in the blood.

**Chapter 2: Body**

**Refereed Journal Article Review 1**

1. Reference: Lixandrão, M. E., Ugrinowitsch, C. A., Laurentino, G. Y., Libardi, C. N., Aihara, A., Cardoso, F., Roschel, H. (2015). Effects of exercise intensity and occlusion pressure after 12 weeks of resistance training with blood-flow restriction. European Journal of Applied Physiology, 115(12), 2471–2480. doi: 10.1007/s00421-015-3253-2
2. Purpose: The purpose of this study was to compare/contrast the effects of different protocols of Blood Flow Resistance Training (BFRT) with diverse occlusive pressures along with exercise intensities in muscle mass and strength.
3. Methods:
4. Subjects:

i: 26 participants

ii: All Male

iii: All of the 26 subjects had not engaged in any resistance or aerobic activity/training in the previous 6 months prior to this experimental period.

iv: All subjects had also been tested and cleared free of any musculoskeletal disorders before participating in the study.

1. Protocol:

i: The training session started with a warm-up on the treadmill for each subject for 5 minutes at 9 km/h before exercising.

ii: The study was performed unilaterally (one leg) using a leg extension machine 2x a week for 12 weeks for a total of 24 sessions.

iii: Blood Flow Resistance Band was place high upon the thigh above quadricep muscle and inflated and maintained occlusive pressure throughout the course of the exercise.

iv: For the first 2 weeks of exercises all groups were instructed to perform 2 sets of exercises. From week 3 on until the end of the study, exercise volume was increased for all subjects.

1. Instruments:

i: Blood Flow Resistance Cuff.

ii: Magnetic Resonance Imaging (MRI)

iii: Treadmill

iv: Leg extension machine.

1. Training Program:

i: 2 times a week for 12 weeks for a total of 24 sessions.

ii: No other or outside training program was used for this experiment aside from the study itself.

1. Results:

i: muscle cross-sectional area (CSA) 0f the quadricep was increased drastically from pre to post testing in all groups except that of BFRT 20/40 (20% of 1 RM at 40% occlusion pressure).

ii: Comparison amongst the BFRT groups suggested that increase occlusion pressure was effective in creating muscle mass only when the subject trained at lower intensity levels.

iii: Occlusion pressure did not however have a sufficient effect when the BFR cuff was used in higher intensity exercises. (Ex: 60-80% of 1 RM).

iv: Occlusive pressure of the BFR cuffs did not have a positive effect on muscle hypertrophy (growth) when exercise intensity increased.

1. Conclusion:

i: .The conclusion from this study can show the existence of truth behind the idea that very low exercise intensity, such as 20% 1 RM for exercise can profit from increase occlusion pressure on the extremity (Ex: 80% occlusion pressure) when trying to increase muscle mass.

ii: Appears as though there is no beneficial element of combining both higher weight intensities to higher occlusion pressure to muscle hypertrophy.

**Refereed Journal Article Review 2**

1. Reference: Yasuda, T., Ogasawara, R., Sakamaki, M., Bemben, M. G., & Abe, T. (2011). Relationship between limb and trunk muscle hypertrophy following high-intensity resistance training and blood flow-restricted low-intensity resistance training. *Clinical Physiology and Functional Imaging*, *31*(5), 347–351. doi: 10.1111/j.1475-097x.2011.01022.x
2. Purpose: The purpose of this study was to compare any differences between high intensity training and blood flow restriction training in limb and trunk muscles.
3. Methods:
4. Subjects:

i: 30 men aged 22-28

ii: Subjects divided into 3 groups.

iii: All were physically active but had not participated in regular resistance training in a year.

b. Protocol:

i: Training intensity and volume were set at 75% 1-RM.

1. Instruments:

i: BFR Cuff

ii: Free weight bench/free weights

iii: MRI

1. Training Program:

i: HIT and LI-BFR groups worked out 3 days a week for 6 weeks on the free weight bench press.

ii: 3 sets of 10 reps with a rest period of 3 minutes between each set @ 75% 1-RM for HIT group.

iii: For LI-BFR group the weight was set @ 30% 1-RM. 30 reps followed by 3 sets of 15 with 30 sec breaks.

iv: CON group continued with normal workout regime during the 6 weeks.

1. Results:

i: No changes in body mass in any of the subjects after training.

ii: After training 1-MR bench press increased in all groups.

iii: Relative change was greater in the HIT group than the other groups.

iv: Pectoral and tricep brachii CSA increased in both HIT and LI-BFR groups but not CON.

1. Conclusion:

i: Results from this study show that limb and trunk muscle growth (hypertrophy) occur simultaneously during HIT but not in LI-BFR training. This could possibly be due to individual differences in activating certain muscles during the training regime.

**Refereed Journal Article Review 3**

1. Reference: Vechin, F. C., Libardi, C. A., Conceição, M. S., Damas, F. R., Lixandrão, M. E., Berton, R. Tricoli, V., Roschel, H., Cavaglieri, C., Chacon-Mikahil., Mara, P., Ugrinowitsch, C. (2015). Comparisons Between Low-Intensity Resistance Training With Blood Flow Restriction and High-Intensity Resistance Training on Quadriceps Muscle Mass and Strength in Elderly. *Journal of Strength and Conditioning Research*, *29*(4), 1071–1076. doi: 10.1519/jsc.0000000000000703
2. Purpose: This study was conducted to investigate whether BFR training in the elder community would have the same if not greater benefits than that of traditional resistance training.
3. Methods:
4. Subjects:

i: 23 healthy older individuals

ii: 14 men, 9 women

iii: Range from 59-71 years old

iv: Could not have any of the following heath conditions; cardiac disease, arterial hypertension, diabetes mellitus, or any musculoskeletal conditions.

1. Protocol:

i: 1-RM was assessed using leg press machine

ii: Determined BFR cuff restriction by tightening cuff until no pulse presence and then slightly loosening until first arteriole pulse felt. Cuff set at 50% tibial arterial pressure throughout exercise.

1. Instruments:

i: BFR cuffs

ii: Leg press machine

iii: MRI machine

1. Training Program:

i: Subjects performed a 45 degree leg press twice a week for 12 weeks.

ii: HRT group performed 4 sets of 10 on 70% 1-RM for first 6 weeks and then the resistance was increased to 80% for remainder if sessions.

iii: LRT group performed 1 set of 30 rep, and 3 sets of 15 reps on 20% 1-RM for the first 6 weeks and then 30% 1-RM for remainder of sessions.

Iv: 1 minute rest breaks in between sets.

1. Results:

i: Leg press 1-RM for HRT group increased dramatically.

ii: A positive trend of greater values were observed in the LRT-BFR groups.

iii: Quadriceps CSA increased in both HRT and LRT-BFR groups but not CG group.

1. Conclusion:

i: LRT along with partial BFR training can a substitution method of HRT when attempting to maintain or increase muscle mass and strength in elderly persons.

**Refereed Journal Article Review 4**

1. Reference: Yasuda, T., Fukumura, K., Fukuda, T., Iida, H., Imuta, H., Sato, Y. Yamasota, t., Nakajima, T. (2012). Effects of low-intensity, elastic band resistance exercise combined with blood flow restriction on muscle activation. *Scandinavian Journal of Medicine & Science in Sports*, *24*(1), 55–61. doi: 10.1111/j.1600-0838.2012.01489.x
2. Purpose: The purpose of conducting this study was to examine the effects of low intensity blood flow restriction training on muscle activation.
3. Methods:
4. Subjects:

i: 9 healthy men aged from 23 to 41 years old with resistance training experience.

ii: All subjects received written and verbal description of the study along with informed consent prior to participation.

1. Protocol:

i: 1 week prior to study the participants completed an orientation. This included measuring of resting blood pressure, familiarization of BFR band and exercises, along with range of motion (ROM).

ii: Subjects informed to avoid drinking alcohol or caffeine 24 hours before a session as well as any strenuous activity up to 48 hours from next session.

1. Instruments:

i: BFR cuffs

ii: Electromyography (EMG)

iii: Heart rate monitor

iv: Elastic resistance bands

v: Metronome

1. Training Program:

i: Subjects were in a seated position for both bilateral tricep extension and bicep curl.

ii: Exercises performed while using resistance band.

iii: Exercise duration consisted of 1.2 sec eccentric and 1.2 concentric motion which was monitored by a metronome.

iv: session consisted of 30 repetitions followed by 3 sets of 15 reps with 30 sec between each exercise.

v: Before exercise the BFR cuff was place proximal of the arm. The cuff was inflated to 100mmhg for 30 seconds and then deflated for 10 seconds.

vi: This was repeated, inflating the cuff by 20-40mmhg each time until a desirable cuff pressure of around 170-260mmhg was achieved. The cuff was left on for the remainder of the session including rest time.

1. Results:

i: Study concluded that muscle activation was increased with the introduction of BFR band if exercises were performed at low-intensities.

ii: Blood lactate concentration levels also increased following BFR exercises which correlate to increase muscle activation.

1. Conclusion:

i: It can be concluded that BFR training with low-intensity exercises will promote muscle activity.

**Refereed Journal Article Review 5**

1. Reference: Yasuda, T., Ogasawara, R., Sakamaki, M., Ozaki, H., Sato, Y., & Abe, T. (2011). Combined effects of low-intensity blood flow restriction training and high-intensity resistance training on muscle strength and size. *European Journal of Applied Physiology*, *111*(10), 2525–2533. doi: 10.1007/s00421-011-1873-8
2. Purpose: The purpose of this study is to examine combined effect of low-intensity blood flow restriction and high-intensity resistance training on muscle adaptation.
3. Methods:
4. Subjects:

i: 40 “recreationally active” men aged 22-32.

ii: All subjects were nonobese, normotensive, nonsmokers, and not on medication.

1. Protocol:

i: Subjects split into 3 training groups.

ii: Performed a supervised free-weight flat bench press exercise 3 days a week

(Mon, Wed, Fri) for 6 weeks.

iii: Training intensity and volume set at 75% 1-RM and 30 repetitions for first group (HI-RT), 30% 1-RM at 75 repetitions for second group (LI-RT), the third group (CB-RT) performed LI-BFR trice a week (Mon and Wed) and HI-RT once a week on Friday.

iv: Subjects were encouraged to eat similar diets and refrain from ingesting alcohol or caffeine 24 h before pre and post- training.

1. Instruments:

i: Free-weight flat bench.

ii: Elastic cuffs (BFR cuffs)

iii: Isokinetic Dynamometer.

iv: EMG and MRI.

v: Borg scale.

1. Training Program:

i: one week before study, all subjects familiarized with strength training equipment.

ii: 1-RM was assessed with free-weight flat bench, after the warm-up period intensity was estimated at 80% 1-RM and increased by 5% after each successful repetition. 5-6 trials were completed with 2-3 min breaks until estimated 1-RM was achieved.

iii: Performed a supervised free-weight flat bench press exercise 3 days a week (Mon, Wed, Fri) for 6 weeks.

iv: Training intensity and volume set at 75% 1-RM and 30 repetitions for first group (HI-RT), 30% 1-RM at 75 repetitions for second group (LI-RT), the third group (CB-RT, combination of both HI-RT and LI-RT training) performed LI-BFR trice a week (Mon and Wed) and HI-RT once a week on Friday.

v: Subjects were encouraged to eat similar diets and refrain from ingesting alcohol or caffeine 24 hours before and after training.

1. Results:

i: Bench press 1-RM increased HI-RT, LI-BFR, and CB-RT groups, but not with the CON group.

ii: The percent change in 1-RM strength was greater in both the HI-RT and CB-RT groups than in the LI-BFR and CON groups.

iii: Isometric mvc strength increased in the HI-RT and CB-RT groups, but not in the LI-BFR or CON groups.

iv: Percent change in TB muscle CSA was greater in the HI-RT group than in the LI-BFR and CON groups, also percent change in PM muscle CSA was greater in the HI-RT group than in the LI-BFR , CB-RT and CON groups.

1. Conclusion:

i: Combining LI-BFR with HI-RT (CB-RT program) was greater than improvements observed with LI-BFR alone.

ii: Relative strength improved with HI-RT and CB-RT.

iii: Combining the techniques of HI-RT and LI-BFR may be a successful training program for promoting strength adaptations..

**Ch. 3: Summary/Conclusion**

Blood flow resistance training can be a very beneficial aspect to the health care industry. Following correct protocols, supervision, and having knowledge of the science behind blood flow resistance bands can be a positive factor for any age group. All these articles, some more than others, do show and demonstrate that BFRT is a beneficial tool to use when used correctly and in the right situation. The whole idea is that occluding blood from entering the muscle being worked will increase the perceived exertion being lifted by that muscle. This restricted blood flow is said to dramatically increase muscular stress as well as cellular swelling, and in return, there is a significant increase in growth hormones, hypertrophy, and strength. The sessions are also shorter because instead of spending 20-30 minutes on an arm or leg machine, only about 5-10 may be needed with BFR bands since the workout usually consist with high repetitions usually around 20 repetitions and 3-4 sets. Muscles still need about 48 hours in between workouts to fully recover so BFR bands may still be used every day but a different body part a day is recommended. It is also recommended that BFRT is not the only type of exercise used in a training program. A balanced workout regime of cardio, resistance training, stretching, warm-up, and cool-down are still highly advised in order to change things up not only for the body but for the patient as well.

The size of the individual working out as well as the band width can have an effect on how well the bands will work. A narrower band (about 5-9 cm) has a smaller chance of occluding the artery partially, compared to a wider cuff (12+ cm). A person who is smaller or has smaller arm or leg diameters have a higher risk of the band partially occluding their artery compared to someone who has more mass and bigger arms who may have to have the band slightly tighter. According to these articles BFRT does work when the percent 1-RM to percent resistance ratio is met. The ideal ratio is around 20% resistance of 1-RM and 70-80% occlusion pressure. If a cuff doesn’t tell you physically the pressure being applied, a perceived pressure of 7 out of 10 ir recommended. Studies showed that a tighter occlusion pressure with higher resistance does not result in muscle hypertrophy or muscular strength. The band has to be at least 70% occlusive in order to stop/reduce the flow of blood from the veins. Any looser and blood will be able to flow through more freely, defeating the sole purpose of the BFR bands. Also, more resistance will only cause the participant to struggle and compensate more than is needed. The whole idea of the BFR bands is to allow the user to get more muscle growth and strength out of lifting less weight, such as 70-80% of their 1-RM which is usually seen in typical resistance training.

The idea of lifting less weight to see similar results as in tradition weight lifting is extremely beneficial in physical therapy and trainers or nursing homes who work with the elderly. The elderly community have weaker bones, tendons, and less muscular strength overall to lift heavy weights so BFRT allows them to gain muscular strength while tolerating a liftable weight. With the older community being more susceptible to injury and may already have underlying health conditions, BFRT also reduces stress on the bones and joints as well as cardiovascular risk that come along with heavy resistance loading with weights. With BFRT there are no risks with a thrombosis or clot forming while using these bands. The formation of clots however typically comes from an imbalance of coagulation and fibrinolytic which is the breakdown of coagulation products. BFRT training does not increase coagulation and in fact BFRT training may help in the breakdown of clots which makes it even safer to use for those who may be a little skeptic. In the therapy setting, patients who have had recent surgeries or past injuries may be restricted to the amount of weight they can lift or pull, and similar to the older adults this can provide them an alternative route to progressing faster.

While there are many instances that BFRT can be very beneficial in many ways it may not be an answer for everyone. Even with BFRT results still may not be seen for weeks to months out if instructions are followed strictly along with a consistent gym routine. So patience is also a factor to consider. However, with a lot of research and practice with BFRT bands, it is a very beneficial tool to add to any type of therapy or gym setting. Since being around since the late 19060’s BFRT obviously has been an interesting topic that still seems to grab the minds of health care enthusiast throughout the world. It is definitely a technique everyone should try at least once in their field.

Over the years, blood flow resistance training has become more popular and recognized in the world of training and fitness. **“**Practical blood flow restriction training increases muscle hypertrophy during a periodized resistance training programme” takes a deep approach to more of the athletic/fitness realm and how BFRT could possibly impact this area. Traditionally, the American college of Sports Medicine (ACSM) recommends resistance training using intensities >70% 1 rep max for muscle hypertrophy. (Lowery, et. Al, 2013). An idea as simple as using an elastic band over an arm or leg to occlude blood to the muscle has sparked an interest in physical therapy, the sports world, gym fanatics, and the overall health and wellness field. The whole idea is that a person will be able to get just as much benefit if not more from lifting a lift weight with BFR bands than heavy traditional resistance training. As in the other articles, the main focus of this particular article is to determine whether or not BFRT can be equal to if not better than other traditional resistance training programs while only using a fraction of the weight. This concept would lighten the load placed on joints and muscles as well as the stress on the cardiovascular system. The comparison between the BFRT groups demonstrated that increased occlusion pressure was effective on augmenting muscles ONLY when training at lower intensities. (Lowery et. Al,2015). The results showed that CSA of the quadriceps muscle did increase with 20% 1-RM and 40% occlusion pressure but also says that occlusion pressure did not have a sufficient effect when the BFR cuff was used in higher intensity exercises. Furthermore that increasing both resistance and occlusion to higher percentages had no positive effect on muscle mass or hypertrophy.

A tool that is seen useful is looking further into the process and/or a benefit of blood flow resistance training is Magnetic resonance imaging or MRI. This tool will be seen further throughout this research analysis in many other articles and studies as an important tool to look into what is actually happening to the muscle inside the body before, during, and after exercise with a BFR band. MRI techniques are used to determine the cross-sectional area of muscles before and after BFRT is commenced to see how muscles react to BFRT compared to traditional training. In “Effects of exercise intensity and occlusion pressure after 12 weeks of resistance training with blood-flow restriction”, unilateral quadriceps dynamic strength was assessed using 1-RM on a leg extension machine. A vascular doppler probe was placed over the tibial artery to capture its auscultatory pulse. The pressure of the BFR band was determined by using a standard blood pressure cuff which was tightened until the auscultatory pulse was interrupted. Each groups used a different occlusion pressure with RT-80 being the controlled pressure group. The study showed that increasing occlusion pressure had a positive on augmenting muscle mass only when training at lower intensities (Lixandrão, et. al, 2015) Chronic periods of low-intensity training (For example: 20% of 1-rep max dynamic strength along with partial blood-flow restriction) has been shown to promote increases in muscle size and strength compared to those observed after conventional high-intensity resistance training (80% 1-rep max). (Lixandrao et. Al, 2015) Training intensity had a significant impact on increasing quadriceps CSA when comparing BFRT groups with the same occlusion pressure. When it came down to dynamic strength all tests protocols promoted increase dynamic strength when compared to the baseline group. The overall study shows that BFRT training performed with low intensity (about 20% of 1-RM) with a higher occlusion pressure such as 80% may benefit in the aid to improve muscle mass. It has been shown that when it comes to increasing CSA of quadriceps training intensity had more of an effect than occlusion pressure. And in regards to muscle strength this study showed that BFR protocols were less effective than resistance training even with the changes in occlusion pressure and intensities. The conclusion states that an individual may in fact benefit from BFRT if the resistance is kept at 20% 1-RM but the occlusion pressure is kept at a higher pressure such as 80% in order to improve muss mass.

In “Comparisons between low-intensity resistance training with blood flow restriction and high-intensity resistance training on quadriceps muscle mass and strength in elderly”, BFRT is taken into consideration the possible positive effects on older adults. This happens to be the first study to show and compare the differences between LRT-BFRT and HRT on lower limb muscle function and muscular mass in the elderly. Instead of single leg extension exercises this study focused more on the leg press machine in the elderly. While both training technique LRT-BFRT and HRT showed an increase in 1-RM on the leg press machine as well as quadriceps CSA, HRT showed greater strength gains between the two (Vechin, et. al, 2015) CSA allows for researchers to look beneath the skin at the muscles to see how much of a difference there is (if there is any) after BFRT. This makes for much more reliable information than just from looking at the limb or measuring the circumference which would automatically be larger with increase blood flow to the limb so this information might be deemed unreliable. Decrease muscular strength is a common problem with aging adults which promotes strategies to help preserve muscular functionality of the elderly. However there are downsides in introducing BFRT to elderly adults such as cardiovascular impairments, frail bones/joints, and novice RT practitioners with minimal knowledge of BFRT. This study shows how LRT-BFRT can be just as effective as BFRT in increasing CSA of the quadriceps. Overall, both training regimes were effective in increasing the quadriceps CSA and 1-RM for leg press; however HRT improved total strength gains than BFRT. In this case, BFRT may not be suitable for everyday training for the average elderly adult, but may be more beneficial in the field of physical therapy. The end study agreed that BFR training combined with light resistance training could be a valuable substitution in place of high resistance training when attempting to either keep or increase muscle mass and strength in elderly adults (Vechin, et. al, 2015).

Age‐related skeletal muscle loss (sarcopenia) inhibits mobility and increases the risk of developing several diseases such as diabetes, osteoporosis, and heart disease. High‐intensity resistance training can induce muscle hypertrophy and improve insulin resistance and type‐2 diabetes in the elderly, suggesting that high‐intensity resistance training leads to prevention and/or improvement of sarcopenia in the elderly (Yasuda, et. al, 2012). This is a good evidence to show how BFRT isn’t only for muscular adaptations but also has beneficial physiological benefits as well inside the body. It is important however to perform a physical assessment of your client (at any age but especially the elderly) before implementing any BFT training to see if this is a safe alternative. Potential clients or participants should see a doctor before using BFRT to diagnose any underlying conditions. This experiment used 10%, 20%, 30%, 40%, and 50% of 1-RM while other studies used a larger variation of 20%, 40%, 60% and 80% of 1-RM. Again it has shown that the ideal target weight is roughly 20% of an individual’s 1-RM. Previous BFR experiments using machines/free weights suggest that low‐intensity, elastic band resistance exercise combined with BFR enhances muscle activation and therefore recognized Kaatsu training using elastic bands may therefore be an effective method to promote muscle hypertrophy in older adults or in patients capable of tolerating only low‐load resistance exercise. (Yasuda, et. al, 2012). In the end this article strongly agreed that BFR training with low intensities could help promote muscular growth.

“Combined effects of low-intensity blood flow restriction training and high-intensity resistance training on muscle strength and size” tackles this subject straight on comparing RT with BFRT in healthy young male adults. The most applicable age group that seems most interested in this area of study is the young male (22-32 years old). This study theorized that muscular strength alone was not seen in LI-BFR nor HR-RT, but rather in a training protocol where both LI-BFR and HI-RT were introduced together. Studies in the past however have shown that complete occlusions or restrictions of total blood flow in veins may cause a thrombus formation. A thrombosis formation is a microvascular occlusion that occurs after the BFR band has been loosened or released after exercise. This action can then lead to muscle cell damage. Training-induced improvements in isometric and dynamic strength brought about by combining LI-BFR with HI-RT (CB-RT program) were higher than those seen with LI-BFR alone, which were similar to those of HI-RT alone (Yasuda, et.al, 2011). So according to this particular study, it can be concluded that BFR training induced functional muscle adaptations are enhanced by combining BFR with HI-RT. Given the health risks and strength improvement associated with resistance training, a combination of HI-RT and LI-BFR may be an effective training program for promoting strength adaptations in practical applications (Yasuda, et. al, 2011). This study concluded that combining the techniques of high resistance-RT and low resistance-BFR may be a successful training program for promoting strength adaptations.

In conclusion, BFRT is the most beneficial when used in a 20% of 1-RM with 70-80% occlusion pressure. It is beneficial in the gym setting as well mostly in physical therapy in allowing clients/patients to lift lighter loads of weight but obtaining the same benefits as lifting 70-80% 1-RM for 8-10 repetitions on 3-5 sets without placing stress on joints and the cardiovascular system. BFRT when used correctly is a beneficial way to gain muscular hypertrophy and strength.

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